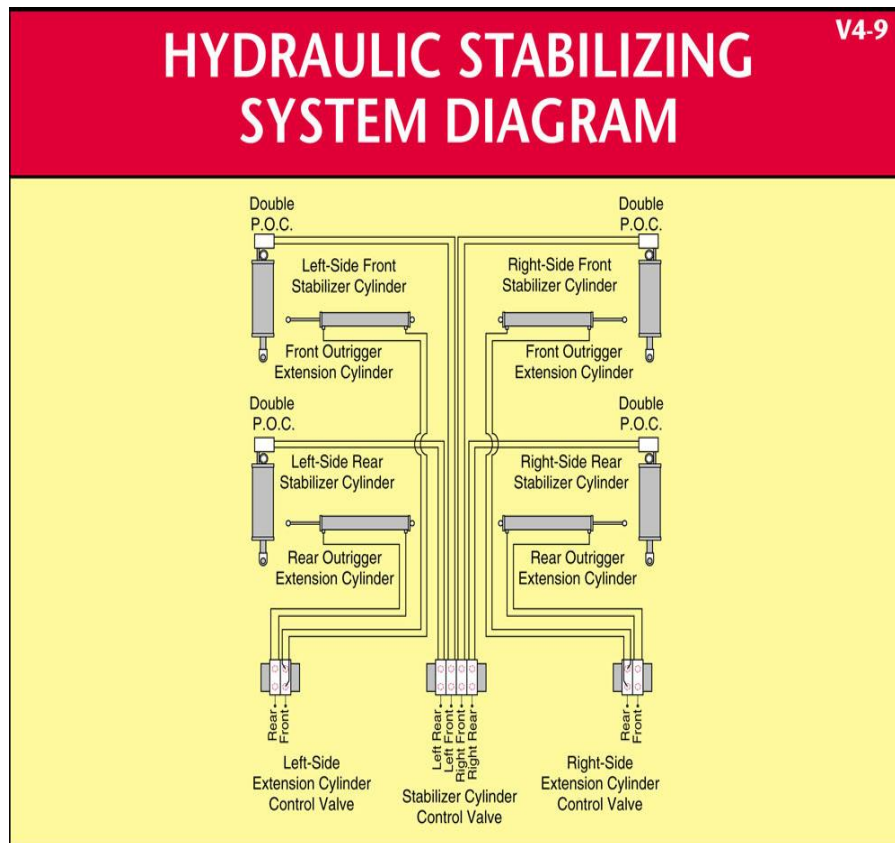


# Hydraulic System Components and Stabilization

## Basics of Aerial Device Hydraulic Systems

Today all aerial devices in Montgomery County are hydraulically powered. Hydraulic fluid is the medium used within the system to transmit force. It is practically incompressible, therefore allowing force to be transmitted over a relatively large area with little loss of power. Depending on the manufacture of the aerial device, the fluid in the system may be under pressures of 3,500 pounds per square inch (psi) or more. Therefore personnel operating around these devices must use caution and operate within the manufactures guidelines.



## Hydraulic Pump

Force is created within the system by a hydraulic pump, and the pump is powered by a power take-off (PTO) arranged from the unit's main engine. Depending on the manufacture, these pumps are usually either rotary vane or rotary gear positive-displacement. Both pumps use a fixed amount of fluid at a given speed which allows for predictable movement.

## Hydraulic Fluid

Hydraulic Fluid moved into the system is supplied from the hydraulic reservoir (tank). Fluid displaced from the system flows back into the reservoir before being re-circulated through the system. The reservoir is designed to supply an adequate amount of fluid to operate the hydraulic system and to condition the fluid while it is stored into the tank. These tanks have baffles inside to slow the movement of fluid. Filters and exchange-type oil coolers are also used to supplement the reservoir's ability to condition the fluid. These coolers are usually located in front of the vehicle's radiator or on some units on the turn table at the base of the aerial ladder.

*Note: Access to hydraulic reservoirs (tanks) is usually limited to the station mechanics. Damage could incur to the system if over-filled or contaminants are introduced to the system.*

## Hoses and Tubing

Hydraulic fluid is supplied through the system by a series of tubing and hoses. Most manufactures use steel tubing and aircraft-type, steel braided hose. According to NFPA 1904, All hydraulic hoses, tubing, and fittings must have a minimum bursting strength of at least three (3) times the maximum operating pressure.



*Note: Do not search for hydraulic leaks using your body as fluid under pressure can be injected into the skin. Use a tool or other object to probe as necessary.*

## Check Valves

Check valves prevent fluid from flowing backwards through a component and act as a safety feature to restrict fluid loss in the event of a leak in the system.

## Relief Valves

Relief Valves limit the pressure built up in the system, thus preventing damage due to over pressurization.

## Counter balance Valves

These valves prevent unintentional or undesirable motion of the device from position.

## Selector Valve

The selector valve (also known as a diverter valve or transfer valve) is one of the more important valves in the system. Most valves have three positions: stabilizer, aerial, and an off or neutral position. They may be a toggle switch or a push-pull device. The selector valve chooses what part of the hydraulic system is pressurized depending upon what vehicle function is desired; i.e. setting the stabilizers or moving the aerial.



**Diverter valve**



**Selector valve**

## Hydraulic Cylinders

Hydraulic cylinders convert the energy in the system into linear mechanical force or motion. This is accomplished when pressurized hydraulic fluid is directed into a chamber created by fitting a piston into a cylindrical barrel. Hydraulic cylinders used for elevation and telescopic control of the aerial device and for operating the stabilizers are double acting. Double-acting cylinders are capable of receiving fluid under pressure from both sides of the piston so that force is available both when extending and retracting the piston.



## Stabilizer Cylinders

These cylinders are deployed anytime the aerial device is raised from its bed. They prevent the apparatus from tipping over when the aerial device is raised and maneuvered. Depending on the design of the apparatus, each stabilizer may be operated by one or two hydraulic cylinders. The cylinders force the stabilizer arms out and down to take the apparatus off of the suspension.

## Hoisting Cylinders

Hoisting cylinders are sometimes referred to as elevating cylinders. Their function is to elevate the aerial device from its stowed position. Hoisting cylinders are heavy, seamless steel outer shells bored to an extremely smooth inside surface. The cylinders are often chrome-plated on the inside to resist friction and wear. The cylinders are enclosed at the top and the bottom with removable caps. A solid piston rod, packed and tightly fitted with rings, is inside each cylinder. The piston rods are also chrome-plated to resist wear.

The end of the piston rod outside the cylinder is fitted with a trunnion that is anchored to either the aerial device or to the turntable, depending on the make of the apparatus. The trunnion holds the piston rod in contact with the aerial device or turntable.



Trunnion



Hoisting Cylinders



## Transferring Power to the Hydraulic System

### Power Take-Off (PTO)

The PTO system provides the power to the hydraulic pump, which in turn creates a pressure on the fluid in the hydraulic system. The process of engaging the PTO is fairly similar for all types of vehicles. The engagement switch for the PTO system is usually located on the dashboard of the vehicle or between the driver and officer seats. The type of PTO activation switch varies from manufacture to manufacture and may be pneumatic, electric, hydraulic, or a combination of these three. Pneumatic systems require anywhere from 50 to 140 psi air pressure for the PTO to be operated, depending on the manufacture. Regardless of the type of system used, the overall process for engaging the PTO is the same.



Pneumatic PTO Switch



Electric PTO Switch

### Types of Stabilizers (Jacking Systems)

#### A-Frame Stabilizers

These style stabilizers will be referred to as Scissor, A-Frame, or X-Style stabilizers. They extend down and away from the chassis at an angle. When deployed and in place for operation, these stabilizers viewed from the rear of the vehicle resemble an "A" formation. This style stabilizer cannot be Short Jacked! This style jacking system can be found on E-One rear-mount aerial towers and E-One rear-mount ladder truck.



A-Frame Jack

This style jacking system allows for more compartment space as result of being mounted to the underside of the vehicle.

## Box or H-Style Jacks

These stabilizers extend straight away from the vehicle and then straight down to the ground. If viewed from the front or rear of the vehicle, these jacks can resemble a box or H formation. *They can short jacked only according to the manufactures recommendations and only as a last resort!* This jacking system is probably the most common and can be found on Pierce rearmount aerial towers, Pierce mid-mount aerial towers, and Pierce tractor-drawn aerials.



Box Style Stabilizer

## X-Frame Stabilizers

These stabilizers combine features of both the A-frame and H-style stabilizers. They extend down and away from the chassis at an angle, but also have a vertical cylinder. This style stabilizer can be short-jacked in accordance with manufacturer's recommendations. This style jacking system can be found on the SRV tractor-drawn aerials.



## Setting the Stabilizers

Some manufactures recommend chocking the wheels at this time. This is particularly true of apparatus not designed to be totally lifted off of the ground.



Manufactures should specify whether or not the front or rear wheels are to be chocked. In any event, both sides of the vehicle should be chocked prior to stabilizing. If the vehicle is lifted off of the ground during stabilization, wheel chocks must be removed before lowering or they become jammed under the tires. If using collapsible wheel chocks, ensure that they are locked and properly deployed.

## Expected travel Path

When preparing to set up an aerial device. The travel path of the stabilizers (outriggers) must be anticipated. First knowing the location of the stabilizers in relation to the rest of the vehicle is very important. You must also know the span (the distance of the stabilizers from side to side) of the stabilizers at full extension. There are three basic ways that the stabilizers move into position. Stabilizers that extend straight down from the apparatus, fulcrum styles that swing down into position (none in Montgomery County at this time), and box-types that first extend outward and then down. The operator must be observant of other vehicles, utility poles, hoselines, fences, signs, other personnel, and any other object in close proximity. If there is any doubt as to the room for the stabilizer to deploy, a short pike pole or hook can be used to estimate the travel path and distance required to deploy the stabilizers. If possible, a second firefighter should be positioned in the area of the stabilizers as they deploy to keep people away.



Stabilizer controls come in different variations for different apparatus. Make sure that you have an understanding of how they function. Some of these controls



have an automatic high idle feature that engages when a control is operated, and others have separate high idle switches that have to be engaged manually.



Stabilizer controls

### Operating the Selector Valve

Once the driver has deployed the stabilizers and secured them, the selector valve (which should already be in the jacks/outrigger position) can now be switched to the aerial/ladder position. These selector valves are normally located either on the rear of the truck or on the middle of the truck for midship aerial devices near the stabilizer controls. The type of selector/diverter valve will vary depending on the manufactures.



Stabilizer interlocks lights and Selector valve



Not all aerial devices have selector switches or diverter valves. These types of aerial devices automatically divert the hydraulic power to the aerial once a specified amount of downward force is applied to the stabilizers. On most aerial apparatus, the combination of hydraulic system holding valves and the interlock feature of the selector valve provide automatic locking capabilities. The interlock prevents the flow of hydraulic fluid into or out of the stabilization system while the aerial device is in use. The holding valves prevent the movement of fluid within the stabilization system. The holding valves are activated when the selector switch is moved to the aerial position. Many units in the county are equipped with indicator lights that show when the interlocks are engaged.

### **Stabilizing on Even/Uneven Terrain**

Stabilization is ideally performed on even terrain. Even terrain allows for the maximum stability of the apparatus and for the greatest range of safe movement of the aerial device. Driver/operators must become familiar with the manufactures recommendations.

The box-type stabilizers are the most common type stabilizers utilized on aerial apparatus in Montgomery County. When operating this type of stabilizer, the first operation is to extend the beams to their maximum travel distance, if possible. If full extension of the beams cannot be accomplished, the vehicle is considered “short jacked” on that particular side. As a safety feature on some apparatus, a bypass or override must be engaged to transfer the hydraulic power to the aerial in this situation. On other apparatus, a computer senses the short jack condition and automatically limits the range of motion of the aerial device.

**\*WARNING\***

Extreme caution must be exercised when “short Jacking”! The aerial must not operate off of the short jacked side of the apparatus.

In all situations, operators should seek to extend the stabilizer beams as far as possible to increase the footprint of the unit. Operators need to be familiar with the manufacturer’s guidance for their specific breed of apparatus.

Once the beams have been extended to their final positions, place the portable stabilizer pads (ground pads) directly beneath the stabilizer feet so that they will be in position when the jacks are lowered. If equipped, pin the stabilizers once final positioning has been completed.



Jack with ground pad and pin in place

**\*WARNING\***

***Ground pads must be utilized anytime the aerial device is in use regardless of the ground surface unless otherwise specified by the manufacturer.***

Setting up on uneven terrain is sometimes unavoidable. The driver must still ensure that the apparatus is as stable as possible. There are two ways that the truck can be uneven: **laterally** or **longitudinally**. Of the two, the easiest to correct is lateral unevenness. The amount of correction available is dependent upon the breed of apparatus. Most units will correct lateral unevenness up to 5 to 6 percent. A 5 percent grade means that there is a rise of 5 feet for every run of 100 feet. Once an aerial device is stabilized on uneven terrain (with a grade), the stability of the vehicle can be diminished by as much as half its rated capacity. Driver/operators must be familiar with the requirements for their specific apparatus. Most manufactures recommend that the stabilizers on the high side of the vehicle be lowered first (although there are several units in the county that recommend lowering the low side first). If the high side of the vehicle is recommended to be lowered first, these stabilizers should be lowered only until solid contact is made with the ground. Then, the low side should be raised until that side is raised even with the high side. It is preferable that the aerial device be operated over the high side of the apparatus. If this is not possible, the aerial capacity may need to be de-rated based on the manufacturer's recommendations.

Operating on a longitudinal (end-to-end) grade is a little trickier than operating on a lateral grade. If the turntable is not leveled, the rungs of the aerial device may

not be exactly parallel to the ground if the aerial device is operated over the side of the apparatus. This will generate lateral torsional stresses in the aerial when it is raised and loaded. This can be very destructive to an aerial device. Each manufacture may have different requirements and maximum longitudinal grades for its apparatus. These grades vary from 6 to 14 percent.

### **Stabilizing on Curbs or Other Obstructions**

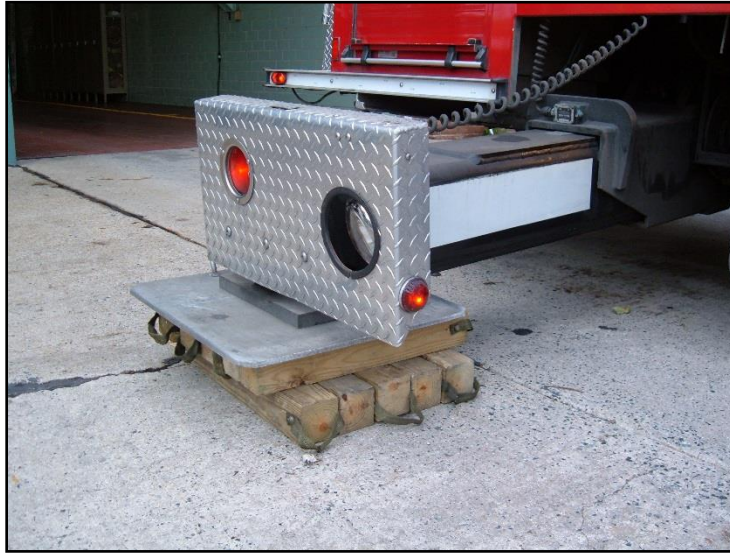
If possible, avoid placing the stabilizers on curbs, sidewalks, parking blocks, water valve covers, or other obstructions. Unfortunately, placement on curbs and obstructions may be unavoidable but an attempt to reposition the vehicle must be made before settling on stabilizing the vehicle on such obstructions. If unavoidable, placement of the stabilizers should be treated the same as setting up on a lateral incline. Make sure that the object to be placed under the stabilizer is solid and capable of supporting the necessary weight.



#### **\*WARNING\***

Setting up on these curbs and grates should be avoided if possible. Curbs may not always have a substantial foundation and failure is a possibility!





Cribbing may be necessary under some circumstances. When cribbing is used, ensure the cribbing is tightly spaced to provide a solid supporting surface for the stabilizer pad. Never place cribbing supporting the beams as this reduces the footprint of the unit. Recall that 4x4 cribbing offers approximately 6,000lbs of capacity per point of contact within the box. Refer to the manufacturer's recommendations!